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A Pot Experiment to Test Effectiveness of The Surface-Placement of Sesbania Debris Prior to Incorporation into The Submerged Soil

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ABSTRACT

The surface-placement of sesbania debris prior to incorporation into the submerged soil was previously proposed as a possible technique to avoid the adverse effect of application of sesbania debris on rice seedlings by suppressing accumulation of organic acids in the soil. Effectiveness of this technique was examined by a pot experiment in a green house. The surface-placed of sesbania debris smelt very bed for few days, probably because accumulation of butyric acid in the debris. When the bad smell disappeared and the sesbania debris became dark and soft, incorporation of the surface-placed sesbania debris ded not show the adverse effect on the rice seedlings. In other words, the time suitable for incorporating the surface-placed sesbania debris could be easily determined without using any analytical tools.

Key wods: organic acid, paddy soil, *sesbania rostrata*, surface-placement of green manure

INTRODUCTION

Effectiveness of sesbania debris as a green manure for paddy rice has been well demonstrated by many studies [Herrera *et al.*, 1989]. However, a few problems still hinder its utilization in farmers' fields. One of them is damage of rice seedlings transplanted soon after incorporation of sesbania debris into the submerged soil. This has been considered to be caused by accumulation of toxic substances, mainly organic acids, when the incorporated sesbania debris is quickly decomposed under anaerobic conditions [Ragland and Boonpuckdee, 1988]. To avert the adverse effect, transplanting of rice seedlings was obliged to be delayed for a certain period. A few studies assigned the necessary period before transplanting [Arunin *et al.*, 1982, Ragland and Boonpuckdee 1988, Herrera *et al.*, 1989]. However, the proposed periods were widely different among scientists. This discrepancy must be related with the fact that the amount and kind of organic acids accumulated in a submerged soil depend on several factors such as the amount of sesbania debris, age of sesbania and soil type [Patcharapreecha *et al.* 1991b]. In addition, if the waiting period is too long, some parts of nitrogen released from the sesbania debris may be lost and farmers will not accept sesbania debris as a green manure.

Under such circumstances, farmers cannot estimate when they should transplant their rice seedlings without damage of the rice and without loss of nitrogen. This problem is expected to be especially serious for sandy soils in Northeast Thailand, because the amount of organic acids accumulated in these soils is large and is sensitive to the above mentioned factors [Patcharapreecha *et al.*, 1991b].

To overcome this problen, Patcharapreecha *et al.* [1991c;1991d] had modified the idea of Ishikawa [1963] so that it is applicable to the rain-fed paddy field in Northeast Thailand. The essential point of Ishikawa [1963]'s idea was that plant debris was incorporated into aerobic soils and after 5 days of aerobic decomposition of the plant debris, the soils

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were submerged. The modified technique was surface-placement of sesbania debris prior to incorporation into the submerged soil. Previous laboratory experiments [Patchrapreecha *et al.*, 1991c; 1991d] indicated that the modified technique was effective to suppress accumulation of organec acids in the submerged soil and that the suitable time for incorporation of the surface-placed sesbania debris could be observed by a few indices such as disappearance of bad smell and darkening and softening of the surface-placed sesbania debris.

The aims of the present pot experiment were to;
1. test whether surface-placement of sesbania debris really eliminate the adverse effect of sesbania debris to rice seedlings,
2. examine whether the indices of time of sesbania debris-incorporation was reliable.

MATERIALS AND METHODS

Soil

A soil sample was collected from a paddy field of Ban Non Muang, Khon Kaen Province, air dried and passed through a 2mm sieve. The soil was classified as Roi-Et series [Fine, loamy, mixed, isohyperthermic Aeric Paleaquults]. Soil analysis con-firmed that it was poor in organic matter and plant nutrients [Tabla 1]. Methods of soil analysis were pH[H_20]; soil:H20=1:2.5, pH electrode, organic matter; Walkley &Black method total N; Kjeldahl distillation technique P [Bray 2]; Murphy & Riley method and Exch. K, Ca, Mg, Na; atomic absorption spectrophotometry.

Sesbania

Sesbania rostrata was cultivated in pots under submerged conditions. Ninety days old sesbania was harvested and cut into pieces of about 3 cm in length and applied to the soil when it was still fresh. As shown in Table 2, the sesbania debris was rich in N and decomposable organic matter.

Preparation of pot and cultivation of rice plant

Ten kilograms portion of the soil sample was placed in each of 15 pots [30 cm in height and 30 cm in diameter] for 5 treat-ments with three replications [Table 3]. In C treatment, the soil was submerged, added with ammonium sulfate at the rate of 1.65g N/10Kg soil [12Kg N/rai], well mixed and transplanted with 21 days old rice seedlings [RD 6]. In OD treatment, the soil was submerged and well mixed with 200 g of the fresh sesbania debris and transplanted in the same way as in C treatment. In all other treatments, the fresh sesbania debris was placed on the surface of the soil which was saturated with water [Figure 1]. The surface-placed sesbania debris was added with small amount of water and pressed to the soil surface to keep it moist, resulting in a moist layer of sesbania debris. This practice was repeated during the experiment when the sesbania debris became dry. Three days [3D treatment], 7 days [7D treatment] amd 14 days [14D treatment] after the surface-placement, the soil was submerged, mixed well with the surface-placed sesbania debris and transplanted with rice seedlings which were taken from the same rice-nursery bed as used for OD treatment. The amount of

Table 1 **Chemical properties of the study soil, (Re) Ban Non Muang.**

pH (1:2.5)	O.M. (%)	Total N (%)	P (ppm)	K	Ca	Mg	Na
					me/100 g		
5.3	0.412	0.038	5.667	0.063	0.934	0.262	0.240

Table 2 **Chemical properties of *Sesbania rostrata* at 90 days.**

Total N (%)	Organic C (%)	C/N	Water soluble carbohydrate (mg/g)	% P
1.76	27.41	15.57	285.52	0.103

Table 3 **Detail of treatment.**

Treatments	Detail
C treatment	12 kg N/rai as (NH4)2SO4 and transplant
OD treatment	200 g Sesbania/10 kg soil incorporate and trasnplant
3D treatment	Surface placement of 200 g sesbania for 3 days before incorporate and transplant
7D treatment	Surface placement of 200 g sesbania for 3 days before incorporate and transplant
14D treatment	Surface placement of 200 g sesbania for 3 days before incoorporate and transplant

nitrogen contained in the sesbania applied to the soil was similar to that in ammonium sulfate applied to C treatment. Growth of the rice plants was observed every day.

RESULTS AND DISCUSSION

Decomposition of the surface-placed sesbania debris

The surface-placed sesbania debris smelt very bad for several days after starting the experiment. The bad smell must be caused by accumulation of organic acids such as butyric acid and indicated that the surface-placed sesbania debris was at least partially anaerobically decomposed. This may be caused by poor aeration inside the layer of compressed moist sesbania debris.

The bad smell was most remarkable 3 days after surface-placement of the sesbania debris. became less remarkable with time and completely disappeared 14 days after the surface-placement. In parallel with this, the surface-placed sesbania debris became darker and softer with elapse of time. The dark color of the sesbania debris was judged to be mainly related with decomposed leaves.

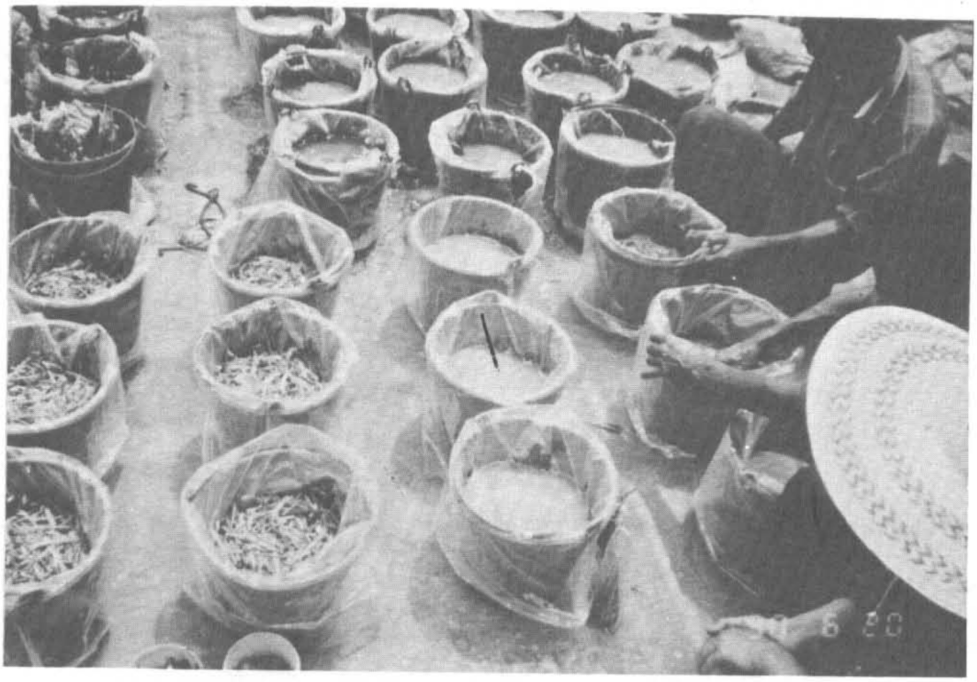

Figure 1 The moist sesbania debris was placed on the surface of soil in bucket.

Growth of rice plant [Figure 2]

In C treatment, rice plants grew vigorously and healthy for a few months. In OD treatment, after a few-week lag period, some seedlings grew slowly but others grew rather quickly and gradually caught up the rice plants in C treatment. In 3D treatment, all the rice seedlings were seriously damaged. Some of them quickly died within a few days after transplanting. The others survived but their growth was very poor. On the contrary, in 7D treatment, growth of the rice seedlings was slightly worse than that in C treatment. Furthermore, in 14D treatment, growth of the rice plant was similar to that in C treatment.

The following suggestions were advanced from these results:

1. In OD treatment, the incorporated fresh sesbania debris was rather slowly decomposed inside the submerged soil, because invasion of anaerobic bacteria into the large pieces of fresh sesbania debris was difficult. Two mechanisms may operate to protect the fresh sesbania debris against quick invasion of anaerobic microorganisms. One was substances which bad abilities to suppress activities of anaerobic microorganisms [Patcharapreecha et al. 1991a]. The fresh sesbania debris might contain this substances more than the dried and stored sesbania debris. The other was large size of the sesbania debris: Anaerobic bacteria could enter into the sesbania debris only through their limited cut ends [Patcharapreecha *et al.* 1991a]. The slow decomposition of the sesbania debris, in turn, resulted in a long-lasting accumulation of organic acids at low concentrations, which suppressed growth of the rice seedlings for a few weeks without killing them. When accumulation of organic acids terminated, rice seedling could start to grow.

2. The surface-placed sesbania debris was partially aerobically and partially anaerobically decomposed on the soil surface. In addition, the decomposition rate of the debris was quicker than that of the incorportated sesbania debris in OD rteament. This because the debris was somewhat mechanically crushed when they were pressed on the soil surface and were attacked by aerobic microorganisms like fungi which had higher abilities to invade the intact plant debris than the anaerobic bacteria. After few days of surface-placement, the sesbania was decomposed at the maximum rate and contained a large amount of organic acids as evidenced by strong bad smell. When this sesbania debris was incorporated into the soil, content of organic acids in the soil became high not only due to incorporation of the previously formed organic acids but also due to organic acids formed in the soil by rapid decomposition of the incorporated sesbania debris which was more

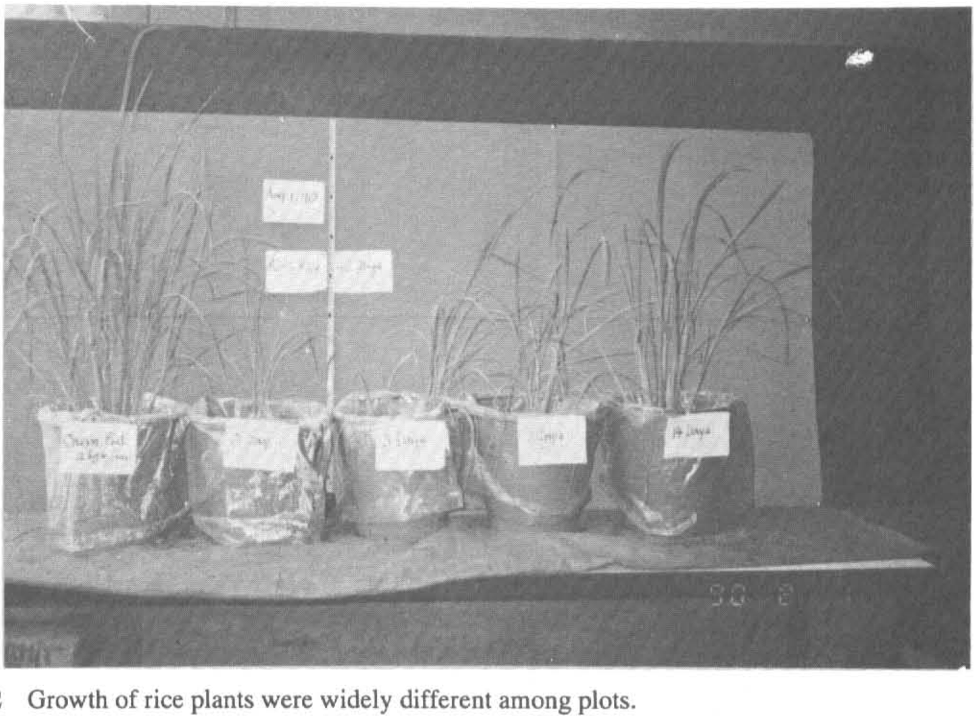

Figure 2 Growth of rice plants were widely different among plots.

vulnerable to anaerobic bacteria than the fresh sesbania debris. Rice seedlings might be seriously damaged in this soil boty by high content of organic acids and by high susceptibility of the rice roots to organic acids just after transplanting.

3. When the surface-placed sesbania debris was kept for more than one week, both a large part of easily decomposable organic substrates of the sesbania debris and the previously formed organic acids were consumed by microorganisms. Consequently, incorporation of the surface-placed sesbania debris at these periods produced only a small amount of organic acids in the submerged soil.

4. If the surface-placed sesbania debris was incorporated into the soil soon after the most of the easily decomposable organic substrates were consumed [when bad smell disappeared and the sesbania debris became dark and soft], loss of inorganic nitrogen was minimal, because nitrification-denitrification must not be active till that time.

On the basis of above suggestions, it may be concluded as follows:

1. The surface-placement of sesbania debris really eliminate the adverse effect of sesbania debris on rice seedlings,

2. Smell, stiffness and color of the surface-placed sesbania debris are simple and reliable indices of readiness of the sesbania debris to be plowed under.

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